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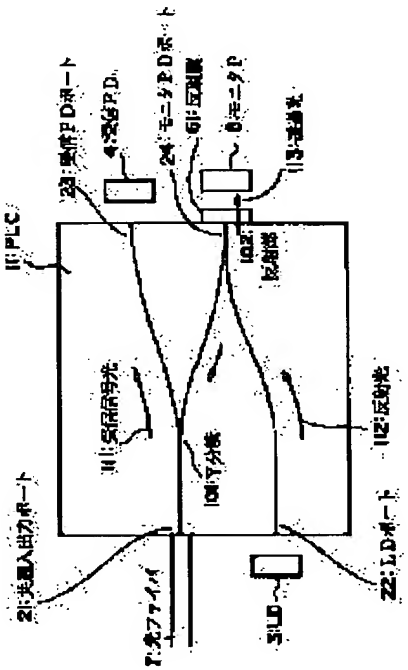
(54) OPTICAL MODULE

(57)Abstract:
PROBLEM TO BE SOLVED: To stabilize a transmission light outputting characteristic of a luminescent element with respect to temperature change and change with the lapse of time under a practical using condition, by arranging a monitoring means for the luminescent element in front of the transmitting direction to monitor directly transmission light.
SOLUTION: This module is an optical module wherein transmission signal light emitted from an LD 3 is transmitted from an optical fiber 7 through an optical waveguide circuit 11. A monitor PD5 for receiving the transmission signal light of the LD 3 is provided in a reflection part 102 for reflecting the signal light of the LD 3 within the circuit 11, and the transmission signal light transmitted through a reflection film 61 of the reflection part 102 is directly received to be monitored by the monitor PD5.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] A photoconductive wave circuit, the optical fiber mounted in this photoconductive wave circuit, and the light emitting device mounted in said photoconductive wave circuit, They are a preparation and the optical module with which the sending-signal light which emits light from said light emitting device is transmitted from said optical fiber through said photoconductive wave circuit. The optical module characterized by having had the monitor photo detector which receives the sending-signal light of said light emitting device, and arranging this monitor photo detector ahead [of said sending-signal light / transmit-direction] in said photoconductive wave circuit.
[Claim 2] The optical module according to claim 1 which said photoconductive wave circuit is equipped with the reflective section which reflects the sending-signal light of said light emitting device in a circuit, and said reflective section is equipped with said monitor photo detector, and receives said sending-signal light.
[Claim 3] The optical module according to claim 2 which said reflective section is equipped with the reflective film which penetrates a part of sending-signal light of said light emitting device, and said monitor photo detector is arranged behind said reflective film, and receives the transmitted light of said sending-signal light.
[Claim 4] The optical module according to claim 1 which said photoconductive wave circuit is equipped with the tee which branches in a circuit in a part of sending-signal light of said light emitting device, and said monitor photo detector is arranged ahead [of said tee / branching direction], and receives the branching light of said sending-signal light.
[Claim 5] The optical module [equipped with the light emitting device drive circuit which controls said light emitting device so that the light-receiving current of the sending-signal light received by said monitor photo detector becomes fixed] according to claim 1 to 4.
[Claim 6] The optical module [equipped with the photo detector to which said photoconductive wave circuit receives the input-signal light received from said optical fiber] according to claim 1 to 5.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] By arranging the monitor means which carries out the monitor of a part of sending-signal light which emits light from a light emitting device especially ahead [transmit-direction] in a photoconductive wave circuit about the optical module which transmits and receives signal light using an optical waveguide circuit, this invention controls the drive current of a light emitting device according to fluctuation of the monitor quantity of light, and relates to the optical module which can stabilize a transmitting optical output property to a temperature change or aging.
[0002]
[Description of the Prior Art] In recent years, the need to a communication line is increasing by the spread of the Internet etc., and not only a trunk system but the need to a subscriber system has been increasing. Especially, by the subscriber system, the demand to communication link cost is severe, and in order to be expansion of a subscriber system optical-communication network, low cost-ization of the optical device for a communication link has been a urgent technical problem. Moreover, by the optical module for subscribers, the optical module which contained optical waveguide and unified the transceiver function for a miniaturization and low-cost-izing is developed.
[0003] Hereafter, the conventional optical module is explained with reference to drawing 5 and drawing 6 . Drawing 5 is the flat-surface block diagram showing the configuration of the conventional optical module. Drawing 6 is the graphical representation showing the relation of the monitor current in LD current, the conventional optical output, and conventional Monitor PD in an optical module.
[0004] As shown in drawing 5 , the optical module which unified the conventional transceiver function consists of PLC (optical waveguide circuit-lanar Light wave Circuit)11 equipped with the reception (Photo Diode) PD 4 and the monitor PD 5, Y branch 101, and the directivity joint mold reflective section 102 used as LD (Laser Diode)3 used as a light emitting device, and a photo detector, and an optical fiber 7 mounted and connected to this PLC11.
[0005] The three I/O sections, common input/output port 21, the LD port 22, and the receiving PD port 23, are formed in PLC11. An optical fiber 7 is mounted in the common input/output port 21 of PLC11, and the sending-signal light and input-signal light from PLC11 combine with an optical fiber 7 efficiently in it.
[0006] LD3 is mounted in the LD port 22, and the sending-signal light which emits light from LD3 combines with PLC11 efficiently. Moreover, the monitor PD 5 which receives the monitor light of LD3 is arranged in the transmit direction and the opposite side of LD3.
[0007] Reception PD 4 is mounted in the receiving PD port 23, and the input-signal light from PLC11 combines with reception PD 4 efficiently. Moreover, the reflective film 62 is attached and the directivity joint mold reflective section 102 carries out total reflection of the sending-signal light from LD3.
[0008] Actuation of the conventional optical module which consists of such a configuration is explained. First, the input-signal light 111 which carried out incidence from the optical fiber 7 spreads the inside of PLC from the common port 21 of PLC11, and is received by reception PD 4 through Y branch 101. A

lightwave signal is changed into an electrical signal by this reception PD 4, and it is inputted into the receiving circuit which was connected to reception PD 4 and which is not illustrated.
[0009] On the other hand, it joins together in the LD port 22 of PLC11, and the inside of PLC is spread by the sending-signal light which emitted light from LD3. Total reflection of this sending-signal light 114 is carried out in the directivity joint mold reflective section 102 equipped with the reflective film 62, and it is spread by reflected light 114a from common input/output port 21 to an optical fiber 7.
[0010] And in order to control fluctuation of sending-signal light by such conventional optical module to be shown in drawing 5 , the monitor PD 5 is mounted so that the monitor light 115 by which outgoing radiation is carried out from the one end side (field opposite to a transmit direction) of LD3 may be received, LD drive current is controlled so that the light-receiving current in a monitor PD 5 becomes fixed, and stabilization of sending-signal light is attained.
[0011] The relation of the monitor current in LD current, the conventional optical output, and conventional Monitor PD in an optical module is shown in drawing 6 . Generally, as shown in drawing 6 (a), above a threshold current (sign 251 of drawing 6 (a)), an optical output 206 and a monitor current 207 both increase the property of LD proportionally with the increment in a current. That is, the optical output and monitor current of LD are in proportionality like a property 210, as shown in drawing 6 (b).
[0012] For this reason, if LD current is controlled so that the variation of a monitor current is observed and this value becomes fixed, a sending-signal output is uniformly controllable as a result. It was possible to have controlled change of a transmitting optical output by this using a monitor current value, when environmental temperature changes and the property of LD changes. As such a conventional optical module, there is "an optical transceiver module" of JP,9-184934,A, for example.
[0013]
[Problem(s) to be Solved by the Invention] When two conditions that the ratio of the quantity of light by which outgoing radiation is carried out from the both-ends side of **LD is always fixed, and the rate which outgoing radiation is carried out and is optically combined with PLC from **LD, i.e., joint loss, is always fixed are filled with the control approach of the sending-signal light in the conventional optical module using the monitor light of such LD, it becomes controllable [the transmitting optical output by the above monitor currents].
[0014] However, on the service condition of an actual optical module, the ratio of the quantity of light by which outgoing radiation is carried out from the both-ends side of LD may change with temperature, and the joint loss between LD-PLC may also change with factors, such as temperature fluctuation and degradation with time. namely, as a fluctuation factor of the sending-signal light in an optical module Although it is controllable by the method controlled using the monitor light of LD to fluctuation of the LD itself since there is not only fluctuation of the luminescence quantity of light of LD but fluctuation of association between LD and PLC and the quantity of light ratio of the transmitting light of LD and monitor light also changes actually This was not able to be stopped, when it was not able to control to fluctuation resulting from optical association with LD and PLC and fluctuation of the sending-signal light by fluctuation of association between LD and PLC arose.
[0015] For this reason, when it changed like the optical output 208 which temperature changes, for example and is shown with the chain line of drawing 6 (a) in control by the monitor current in the conventional optical module, or a monitor current 209, it had resulted in producing dispersion within limits with an optical output like the property 211 shown with the chain line of drawing 6 (b), or 212.
[0016] Thus, by the conventional optical module, the monitor light by which outgoing radiation is carried out from the one end side (back side of a transmit direction) of LD in order to control fluctuation of sending-signal light was received with Monitor PD, and since stabilization of sending-signal light was attained by controlling LD drive current so that the light-receiving current in this monitor PD might become fixed, it was not able to respond to change of the communication environment of the optical module produced under an actual operating condition.
[0017] For this reason, by the conventional optical module, the optical amount of fluctuation was beforehand measured about the optical property containing an optical coupling part, the property needed to be sorted out and only the product needed to be used so that temperature and property fluctuation with

time might be suppressed in a certain specification. Such sorting will affect a manufacture yield and had become a failure for attaining low cost-ization of an optical module.
[0018] In addition, the "optical transceiver module for bidirectional transmission" which makes only one place the multiplexing spectral separation section in a photoconductive wave circuit, and attains miniaturization of an optical module and low loss-ization of a transceiver signal is proposed by JP,7-168038,A. However, the technique given [this] in an official report was not what especially the publication about monitor control of a sending signal does not have for the purpose of the miniaturization of equipment, and low-loss-izing of a signal, and solves the conventional technical problem mentioned above.
[0019] this invention control the drive current of a light emitting device according to fluctuation of the monitor quantity of light , and aim at offer of the optical module which can perform control which stabilize a transmitting optical output property to a temperature change or aging by be propose in order to solve the problem which such a Prior art have , and arrange the monitor means which carry out the monitor of a part of sending signal light which emit light from a light emitting device ahead [transmit direction] in a photoconductive wave circuit .
[0020]
[Means for Solving the Problem] In order to attain the above-mentioned purpose the optical module of this invention according to claim 1 A photoconductive wave circuit, the optical fiber mounted in this photoconductive wave circuit, and the light emitting device mounted in said photoconductive wave circuit, They are a preparation and the optical module with which the sending-signal light which emits light from said light emitting device is transmitted from said optical fiber through said photoconductive wave circuit. It has the monitor photo detector which receives the sending-signal light of said light emitting device, and this monitor photo detector is considered as the configuration arranged ahead [of said sending-signal light / transmit-direction] in said photoconductive wave circuit.
[0021] By the optical module according to claim 2, said photoconductive wave circuit is equipped with the reflective section which reflects the sending-signal light of said light emitting device in a circuit, and, specifically, said monitor photo detector is considered as the configuration with which said reflective section is equipped and which receives said sending-signal light. Especially, in claim 3, said reflective section is equipped with the reflective film which penetrates a part of sending-signal light of said light emitting device, and it has considered as the configuration in which said monitor photo detector is arranged behind said reflective film, and receives the transmitted light of said sending-signal light.
[0022] On the other hand, by the optical module according to claim 4, said photoconductive wave circuit is equipped with the tee which branches in a circuit in a part of sending-signal light of said light emitting device, and said monitor photo detector is considered as the configuration in which it is arranged ahead [of said tee / branching direction], and the branching light of said sending-signal light is received.
[0023] Moreover, it has considered as the configuration equipped with the light emitting device drive circuit which controls said light emitting device by the optical module according to claim 5 so that the light-receiving current of the sending-signal light received by said monitor photo detector becomes fixed. And the optical module according to claim 6 is constituted as an optical module of transceiver functional one apparatus equipped with the photo detector to which said photoconductive wave circuit receives the input-signal light received from said optical fiber.
[0024] Since the function which penetrates a part of sending-signal light, or carries out a direct monitor by branching is added to PLC according to the optical module of this invention which consists of such a configuration, the stable property without fluctuation of the sending-signal light by temperature fluctuation or fluctuation with the passage of time can be acquired by controlling LD drive current according to fluctuation of the monitor quantity of light.
[0025] That is, in this invention, even if various fluctuation factors arise under an actual service condition unlike the approach of receiving the conventional monitor light and performing a monitor since the direct monitor of a part of sending-signal light is carried out, and fluctuation of sending-signal light can be observed directly, it becomes controllable very with high precision to the fluctuation.

Thereby, in this invention, very few stable properties of fluctuation of sending-signal light can be acquired.

[0026]

[Embodiment of the Invention] Hereafter, the operation gestalt of the transceiver functional one apparatus light module of this invention is explained with reference to a drawing.

The [first operation gestalt] The first operation gestalt of the transceiver functional one apparatus light module of this invention is first explained with reference to drawing 1 - drawing 3 . Drawing 1 is the flat-surface block diagram showing the optical module concerning the first operation gestalt of this invention. Drawing 2 is a block diagram about LD drive circuit of the optical module concerning this operation gestalt. Moreover, drawing 3 is the graphical representation showing the relation of the monitor current in LD current, optical output, and Monitor PD in the optical module concerning this operation gestalt.

[0027] The transceiver functional one apparatus light module which applies to this operation gestalt as shown in drawing 1 is the optical module with which the transceiver function was unified, and consists of an optical waveguide circuit 11 (PLC:Planar Light wave Circuit) which consists of the reflective section 102 equipped with the reception (Photo Diode) PD 4 and the monitor PD 5, Y branch 101, and the reflective film 61 used as LD (Laser Diode)3 used as a light emitting device, and a photo detector, and an optical fiber 7 which were mounted and connected to this PLC11.

[0028] The four I/O sections, common input/output port 21, the LD port 22, the receiving PD port 23, and the monitor PD port 24, are formed in PLC11. The optical fiber 7 is mounted and connected to the common input/output port 21 of PLC11, and sending-signal light and input-signal light combine with it efficiently between PLC11 and an optical fiber 7.

[0029] LD3 is mounted in the LD port 21, and the luminescence light of LD3 combines with PLC11 efficiently. In addition, with this operation gestalt, since the monitor PD 5 located ahead of sending-signal light performs the monitor of LD3, the luminescence light of LD3 can emit light towards a transmit direction altogether. That is, it is not necessary to emit light in monitor light to monitors in a transmit direction and an opposite direction, and the luminous efficiency of LD3 can be raised like the conventional LD.

[0030] Reception PD 4 is mounted in the receiving PD port 23, and the input-signal light from PLC11 combines with reception PD 4 efficiently. The monitor PD port 24 constitutes the reflective section 102 equipped with the reflective film 61 which penetrates the light of a certain fixed rate. This reflective film 61 penetrates the light of a certain fixed rate, and the monitor PD 5 is arranged behind the reflective film 61, and it is mounted in it. Thereby, a part of sending-signal light which penetrated the reflective film 61 combines with a monitor PD 5 efficiently.

[0031] As mentioned above, PLC11 of this operation gestalt constitutes the optical module of transceiver functional one apparatus equipped with LD3 and reception PD 4. In addition, there is a thing using a quartz ingredient and plastic material as an ingredient which forms PLC11, and it does not ask especially about the ingredient or manufacture approach.

[0032] Next, actuation of the optical module of this operation gestalt which consists of such a configuration is explained with reference to drawing 1 . First, the input-signal light 111 which carried out incidence from the optical fiber 7 spreads the inside of PLC from the common port 21 of PLC11, and is received by reception PD 4 through Y branch 101. A lightwave signal is changed into an electrical signal by this reception PD 4, and it is inputted into the receiving circuit which was connected to reception PD 4 and which is not illustrated.

[0033] On the other hand, it joins together in the LD port 22 of PLC11, and the sending-signal light 112 which emitted light from LD3 spreads the inside of PLC. Most reflects in the reflective section 102 to which the reflective film 61 was added, and this sending-signal light 112 is spread by reflected light 112a from common input/output port 21 to an optical fiber 7.

[0034] On the other hand, by the reflective film 61, the light of a certain rate penetrates and this transmitted light 113 is received with a monitor PD 5. By observing the light-receiving current outputted from the monitor PD 5, the monitor of the amount of fluctuation of sending-signal light 112a can be

carried out.
[0035] Here, although it is necessary to set up the ratio of the reflected light in the reflective section 102, and the transmitted light according to the conditions which use the optical module concerning this operation gestalt, if it has set up so that it may become an about [reflected light:transmitted light =10:1] rate, for example, the transmitted light, i.e., monitor light, will be set to about 100 microwatts to 1mW of reflected lights, i.e., sending-signal light.
[0036] With reference to drawing 2 , the condition of control of the sending-signal light in the optical module of this operation gestalt is explained. As above-mentioned, the part penetrates the reflective film 61 and the sending-signal light 110 which emitted light from LD3 is received with a monitor PD 5. And to become a fixed value with this light-receiving current, feedback starts LD drive current by LD drive circuit 8, and LD3 is controlled so that sending-signal light becomes a fixed value.
[0037] Thus, the relation between LD current controlled by LD drive circuit 8, an optical output, and a monitor current is shown in drawing 3 . Generally, as shown in drawing 3 (a), above a threshold current (sign 250 of drawing 3 (a)), an optical output 201 increases the property of LD proportionally with the increment in a current. Moreover, since the monitor current 202 is observing a part of transmitting light of LD3, it shows the same property as an optical output, and the optical output and monitor current of LD are in proportionality fundamentally, as shown in the property 205 of drawing 3 (b).
[0038] Here, with this operation gestalt, since the direct monitor of a part of transmitting light of LD3 is carried out by making the reflective film 61 penetrate, the optical output of LD and the relation of a monitor current are not influenced like before of factors, such as a ratio of the quantity of light by which outgoing radiation is carried out from the both-ends side of LD, and optical coupling loss between LD-PLC, and the effect of other temperature fluctuation or degradation with the passage of time hardly receives them, either.
[0039] That is, although the sending-signal light which emitted light from LD is combined in LD port of PLC, and it combines with an optical fiber from common input/output port after most reflects in the reflective section to which the inside of PLC was spread and the reflective film was added, the sending-signal light of a certain rate penetrates the reflective film, and is received with Monitor PD.
[0040] For this reason, when temperature changes, for example, as for most those of the property 205 of drawing 3 (b), change is not seen even if it changes like the optical output 203 shown with the wavy line of drawing 3 R> 3 (a), or a monitor current 204. Therefore, the stable property with little fluctuation of the sending-signal light by temperature fluctuation and fluctuation with the passage of time of sending-signal light can be acquired by observing the light-receiving current which was received with this monitor PD and transformed into the electrical signal, and controlling LD drive current.
[0041] That is, if LD current is controlled so that the variation of a monitor current is observed and this value becomes fixed, a sending-signal output will be controlled almost uniformly. therefore, using-by optical module of this operation gestalt-only product within specification which has measured amount of beforehand optical fluctuation which was performed conventionally ****** -- things also become unnecessary at all
[0042] As explained above, the stable property without fluctuation of the sending-signal light by temperature fluctuation or fluctuation with the passage of time can be acquired by adding to PLC the function which carries out the monitor of a part of sending-signal light, and controlling LD drive current by the transceiver functional one apparatus light module concerning this operation gestalt according to fluctuation of the monitor quantity of light.
[0043] That is, by the optical module of this operation gestalt, even if various fluctuation factors arise under an actual service condition unlike the approach of receiving monitor light like before and performing a monitor since the direct monitor of a part of sending-signal light is carried out, and fluctuation of sending-signal light can be observed directly, it becomes controllable very with high precision to the fluctuation. By this, very few stable properties of fluctuation of sending-signal light can be acquired with this operation gestalt.
[0044] The [second operation gestalt], next the second operation gestalt of the transceiver functional one apparatus light module of this invention are explained with reference to drawing 4 . Drawing 4 is the

flat-surface block diagram showing the optical module concerning the second operation gestalt of this invention.

[0045] As shown in this drawing, it is made to carry out a monitor in a part of transmitting light which the transceiver functional one apparatus light module of this operation gestalt is the modification implementation gestalt of the transceiver functional one apparatus light module in the first operation gestalt mentioned above, and branched having penetrated and carried out the monitor of the transmitting light of LD with the reflective film with the first operation gestalt by the tee.

[0046] That is, the optical module concerning this operation gestalt consists of LD3, reception PD 4 and PD5 for monitors, PLC (photoconductive wave circuit)12 that consists of two Y branches 103 and 104, and an optical fiber 7.

[0047] Common input/output port 21, LD port 22a, the receiving PD port 23, and the four I/O sections of monitor PD port 24a are formed in PLC12. An optical fiber 7 is mounted in the common input/output port 21 of PLC, and sending-signal light and input-signal light combine with it efficiently between PLC12 and an optical fiber 7.

[0048] LD3 is mounted in LD port 22a, and the luminescence light of LD3 combines with PLC12 efficiently. Reception PD 4 is mounted in the receiving PD port 23, and the input-signal light from PLC12 combines with reception PD 4 efficiently in it.

[0049] Furthermore, the monitor PD 5 for receiving sending-signal light is mounted in monitor PD port 24a. And with this operation gestalt, as shown in drawing 4 , while one signal light (output sending-signal light 116a) spreads [the sending-signal light 116 which emitted light from LD3] from common input/output port 21 to an optical fiber 7 through Y branch 104, branched another signal light (monitor sending-signal light 117) is received with a monitor PD 5.

[0050] Next, actuation of the optical module concerning this operation gestalt which consists of the above configurations is explained. In addition, since it is the same as that of the case of the first operation gestalt shown in drawing 1 , the actuation about input-signal light is omitted. It joins together by LD port 22a of PLC12, and the sending-signal light 116 which emitted light from LD3 spreads the inside of PLC, and is spread by one signal light 116a from common input/output port 21 to an optical fiber 7 through Y branch 104.

[0051] Light is received with a monitor PD 5 and the sending-signal light 117 which branched in another port is changed into an electrical signal. By observing the light-receiving current outputted from this monitor PD 5, the monitor of the amount of fluctuation of sending-signal light can be carried out.

[0052] Thus, the same effectiveness as the case of the first operation gestalt mentioned above can be acquired also with the optical module of this operation gestalt. That is, since it branches, the monitor of a part of sending-signal light of LD is carried out and LD drive current is controlled by this operation gestalt according to fluctuation of the monitor quantity of light, fluctuation of sending-signal light can be observed directly and the stable property without fluctuation of the sending-signal light by temperature fluctuation or fluctuation with the passage of time can be acquired.

[0053] In addition, the transceiver functional one apparatus light module of this invention is not limited only to the operation gestalt mentioned above, and it cannot be overemphasized that various modification implementation is possible in the range of the summary of this invention. For example, although the optical module constituted the optical module of transceiver functional one apparatus equipped with the both sides of LD and Reception PD from an operation gestalt mentioned above, as long as it has the monitor control structure of LD of this invention, you may be the optical module of only a transmitting function.

[0054]

[Effect of the Invention] As explained above, according to fluctuation of the monitor quantity of light, the drive current of a light emitting device can be controlled by arranging the monitor means which carries out the monitor of a part of sending-signal light which emits light from a light emitting device ahead [transmit-direction] in a photoconductive wave circuit according to the transceiver functional one apparatus light module of this invention, and control which stabilizes a transmitting optical output property to a temperature change or aging can be performed.

[Translation done.]